

# PATENT SPECIFICATION

DRAWINGS ATTACHED

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## COMPLETE SPECIFICATION

### Improvements in and relating to the Treatment of Waste Gases

We, SIMON-CARVES LIMITED, a British Company, of Cheadle Heath, Stockport, County of Chester, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the treatment of waste gases and in particular to the removal of sulphur oxides from flue and stack gases.

Previous methods of removing sulphur oxides from flue gases have involved the production of waste materials such, for example, as calcium sulphate, which are difficult to dispose of and/or have little or no commercial value. Previous treatment processes have also involved washing or scrubbing the gases with aqueous solutions, with the result that they were cooled and saturated with water vapour and, after release from a chimney stack, rapidly fell to the ground, carrying with them objectionable chemical deposits.

By use of the present invention, in which the washing medium contains a high concentration of sulphuric acid, the gases remain comparatively dry and any deposit on the ground is accordingly slower and less concentrated. Furthermore, the process, once it has been brought into operation, is independent of supplies of raw materials, and depends solely upon a supply of electrical power and water. As the process also produces sulphuric acid in excess of the quantity required for the operation thereof it is also a source of production of a commercially-valuable by-product.

As the only consumable requirements are electricity and water, the process is particularly adapted for use in the treatment of the stack gases of electrical power stations, although, as the electrical consumption is comparatively low, it is also suitable for use

in any appropriate installation where a supply of electrical power is available.

The object of the invention is to provide a process for treating waste gases for the removal of sulphur oxides therefrom, whereby disadvantages of previously-known such processes are substantially eliminated.

Where, in the following description and claims, the term "washing" is used, this term is to be regarded as including the alternative term "scrubbing" as applied to the liquid cleansing of gases.

According to the invention, therefore, a process for the removal of sulphur oxides from waste gases comprises the steps of washing said gases with an aqueous solution of between 40% and 80% of sulphuric acid containing persulphuric acids and hydrogen peroxide, passing at least a portion of the used washing liquor through an electrolytic cell for regeneration thereof, and returning the regenerated liquor back to the washing stage of the process.

In the accompanying drawing is shown one suitable electrical and flow circuit in which the invention may be carried out. Other arrangements will be obvious to those skilled in the art.

In carrying out the invention in the form illustrated, the plant used to operate the process comprises a scrubbing tower 11 into the lower portion of which the waste gas to be treated is admitted through a conduit 12 from a smoke stack, chimney or flue (not shown). The inner end of the conduit 12 is provided with a distributing device such as a nozzle bank 13 which spreads the gas over the inner area of the tower and directs it upwards therein towards an outlet conduit 14 for the cleaned gas.

The washing or scrubbing liquor is admitted to the top of the tower 11 through a conduit 15, to the inner end of which is

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attached a downwardly-directed bank 16 of spray nozzles which distribute the liquid into intimate contact with the rising gas. The nozzle bank 13 is located some distance above the base of the tower 11 so that the washing liquid, after passing through the rising gas, can form a well 17 at the base of the tower below the nozzle bank 13.

The washing liquid is an aqueous solution of between 40% and 80% of sulphuric acid containing persulphuric acid and hydrogen peroxide ( $\text{H}_2\text{SO}_4 + \text{H}_2\text{SO}_5 + \text{H}_2\text{S}_2\text{O}_8 + \text{H}_2\text{O}_2$ ) and during its fall down the tower it mixes with the rising gases. The sulphur dioxide in the gas is oxidised to sulphur trioxide which dissolved in the sulphuric acid in the washing liquor. Any sulphur trioxide in the incoming gas is similarly dissolved.

The sulphuric acid and dissolved sulphur trioxide is taken from the outlet 18 of the tower 11 to a branch conduit, one limb 19 of which leads through a pump 20 to the coil 21 of a cooling tank 22 and the other limb 19a of which leads through a pump 22 back to the liquid inlet conduit 15.

As the oxidation occurs in the tower 11, the concentration of persulphuric acid and hydrogen peroxide in the washing liquor is reduced.

To regenerate these, a part, or all, of the used washing liquor from the well 17 is passed by the pump 20 through the cooling coil 21 through a conduit 23 to an electrolytic cell 24 in which are located an anode 25 and a cathode 26 in circuit with a suitable D.C. source 27 (shown for convenience in the drawing as battery of electric cells, although it will be obvious that in practice this source of potential will be any suitable source of rectified current).

The electrolysis of the used liquor in the cell 24 will cause further persulphuric acid and hydrogen peroxide to be produced and this is recycled to the washing liquor inlet conduit 15 through a conduit 28 by a pump 29.

Due to the reaction between the washing liquor and waste gas in the tower 11 the proportion of sulphuric acid in the  $\text{H}_2\text{SO}_4 + \text{SO}_2$  mixture leaving the well 17 through the conduits 18 and 19 is greater than that entering the tower through the conduit 15 in the  $\text{H}_2\text{SO}_4 + \text{H}_2\text{SO}_5 + \text{H}_2\text{S}_2\text{O}_8 + \text{H}_2\text{O}_2$  mixture, and a portion of this is drawn off the conduit 19 through a conduit 30 and the sulphuric acid therein, partly produced by decomposition of the persulphuric acid, is recovered in the known way. If desired, the whole of the persulphuric acid in the used liquor stream may be decomposed by, if necessary, the heating of the stream.

To maintain the volume of liquor in the circulating system, water is continuously added by a conduit 31 to the inlet conduit 15

in the same volume as the withdrawal through the conduit 30.

Cooling water to the cooling tank 22 is admitted through an inlet conduit 32 and overflows through an outlet conduit 33.

For the production of persulphuric acid in the cell 24 it is of advantage that halogen ions should be present in the liquor undergoing electrolysis and these may be added as necessary. Since, however, the waste combustion gases of many fuels contain hydrogen chloride, a proportion of halogen ions will often be already present in the liquor when it reaches the cell 24. Thus, it may not be necessary to add such ions or, alternatively, those present may only require to be supplemented.

If it is desired that the product sulphuric acid, i.e. that produced from the effluent of the conduit 30, shall be free from hydrogen-chloride this may be washed from the waste gases with water, in the known way, prior to the introduction of the gases to the tower 11. Alternatively, it may be removed from the product sulphuric acid by distillation.

The respective recirculation, effluent and water addition volumes may be controlled by suitable adjustment of the valves 34 and 35 in conduits 19 and 19a, 36 in conduit 30 and 37 in conduit 31.

It will be appreciated that the above description is based upon the particular circuit shown in the drawings and it will be obvious to those skilled in the art that the precise arrangement of parts and flow lines is subject to such variation as may be needed to adapt the invention to particular circumstances and as will permit the practising of invention within the scope of the following claims.

#### WHAT WE CLAIM IS:—

1. A process for the removal of sulphur oxides from waste gases, comprising the steps of washing said gases with an aqueous solution of between 40% and 80% of sulphuric acid containing persulphuric acid and hydrogen peroxide, passing at least a portion of the used washing liquid through an electrolytic cell for regeneration thereof, and returning the regenerated liquor back to the washing stage of the process.

2. A process according to Claim 1, comprising the steps of recycling a portion of the used washing liquid back to said washing stage independently of said electrolytic cell.

3. A process according to Claim 1 or Claim 2, comprising the step of passing used washing liquid through a cooling tank on its way to the electrolytic cell.

4. A process according to Claim 1, 2 or 3, comprising the steps of withdrawing a portion of said used washing liquor from the flow thereof to said electrolytic cell and adding an equivalent volume of water to the regenerated washing liquor at or about the point of its

entry to a washing tower in which the washing of said gases takes place.

5 5. A process according to Claim 4, wherein the used washing liquor withdrawn is processed for the recovery of sulphuric acid therefrom.

10 6. A process according to any preceding claim, comprising the step of adding halogen ions to the used washing liquor at, or about, its point of entry into said electrolytic cell.

15 7. A process according to any preceding claim, comprising the step of washing from said waste gas any hydrogen chloride present therein prior to it being washed with said aqueous solution.

8. A process according to Claim 5 or to Claim 6 as appended to Claim 5, comprising the step of removing by distillation any hydrogen chloride present in the recovered sulphuric acid. 20

9. A process for the removal of sulphur oxides from waste gases, substantially as herein described with reference to the accompanying drawing.

10. A process for the removal of sulphur oxides from waste gases, substantially as herein described. 25

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## COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*